Quantity-quality interactions in Welsh vowels: Phonologization across dialects

Quantity-quality interactions in Welsh

Phonologization across dialects

Pavel Iosad
University of Edinburgh
pavel.iosad@ed.ac.uk

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1 Quantity and quality in Welsh

1.1 A contrastivist conundrum

The Contrastivist Hypothesis
The phonological component of a language L operates only on those features which are necessary to distinguish the phonemes of L from one another (D. C. Hall 2007, p. 20)

- Question here: how do you decide the set of phonemes to be distinguished by features?

- A well-known problem for phonemic theory: mutually predictable distributions
- North Germanic, e. g. Norwegian: [ta:k] 'roof' ≠ [tak:] 'thanks'

- If vowel length is phonemic, then consonant length is allophonic
- If consonant length is phonemic, then vowel length is allophonic
- See for instance Fretheim (1969), Eliasson (1985), Kristján Árnason (1980), Kristoffersen (1999), Rice (2006)

- English *key*: /ki:/ or /ki/?
- English *kit*: /kit/ or /kɪt/?
- Or even syllable cuts?

The problem
Any contrastivist approach appears *forced* to make a choice, even when purely empirical adjudication is difficult

- See, for example, and among many others:
  - English: Chomsky & Halle (1967), Labov (1994), Murray (2000), Durand (2005)
  - Dutch: Smith et al. (1989), Booij (1995), Botma, Sebregts & Smakman (2012), Botma & van Oostendorp (2012)
  - German: T. A. Hall (1992), Spiekermann (2000), Zonneveld et al. (1999)

1.2 Quantity and quality in Welsh

The received view

- Descriptions of Welsh argue it to be essentially like English
- Mutually predictable distribution of length and quality
  - Long vowels are tense [iː uː eː oː]
  - Short vowels are lax [ə ɪ ʊ ɛ ɔ]
  - Disagreement about [a]/[ɑː]

For discussion, see Watkins (1967), G. E. Jones (1984), Awbery (1986), Ball & Williams (2001), Wmffre (2003), Mayr & Davies (2011)

The evidence: quality is phonemic

- English borrowings like [ˈbrɔːn] *brawn*: length does not predictably lead to tenseness
  - ☞ Unclear status in the grammar
  - ☞ Not empirically shown that borrowed [ɛː ɔː] qualitatively identical to native [ɛ ɔ]
  - ☞ Unclear whether [a]/[aː] are distinct qualitatively
- Difficult to account for patterning

The evidence: quantity is phonemic

For the details of this analysis, see Iosad (2012b)

- Distribution within 'short-long' or 'lax-tense' pairs is largely predictable
  - Long before [b d g f θ χ v ð]
  - Short before (most) clusters (but always predictable in any case)
  - Short before [p t k s ʃ ɬ m ŋ]
  - [ə] is always short
  - Lexical contrast before [n l r]

(1) South Welsh

a.	[ˈtʰoˑnɛ]	*tonau*	'tunes'
b.	[ˈtʰɔnˑɛ]	*tonnau*	'waves'

- Partially predictable distribution of quantity driven by quality of surrounding vowels: mix of coerced and distinctive weight (Morén 2001)
- Analysis: general bimoraicity requirement moderated by lexical moraicity and constraints on what can and can't acquire a mora
  - Metropolitan New York English (Morén 2001)
  - Latvian (Bye & de Lacy 2008)
  - Friulian (Iosad 2012a, Torres-Tamarit forthcoming[a],[b])

Dialect variation in length

- All dialects: long and short vowels in stressed monosyllables

☞ *ton* 'wave' [ˈtʰɔnˑ] ≠ *tôn* [ˈtʰoːn] 'tune'

- South Welsh: long and short vowels in stressed penults

☞ [ˈtʰɔnˑɛ] *tonnau* 'waves' ≠ [ˈtʰoˑnɛ] *tonau* 'tunes'

- North Welsh: only short vowels in penults

☞ [ˈtʰɔnˑa] *tonnau* = [ˈtʰɔnˑa] *tonau*

- Mid Welsh and NE (Awbery 1984): 'free variation' in penults

1.3 South-West Welsh

A different pattern

- South-West Wales: Pembrokeshire, western Carmarthenshire, (southern) Cardiganshire (Awbery 1986, C. Jones & Thorne 1992, Wmffre 2003)
- Description: mid long vowels are lax before a high vowel

(2) a. [ˈeːdɛ] *edau* 'thread'

b. [ˈoːgɔv] *ogof* 'cave'

(3) a. [ˈtʰɛːbɪg] *tebyg* 'similar'

b. [ˈkʰɔːdi] *codi* 'rise'

(4) Alternations [ˈkʰoːdɔð] *cododd* '((s)he) rose'

- This could be construed along the same lines as the borrowing argument
- But the distribution is still predictable!

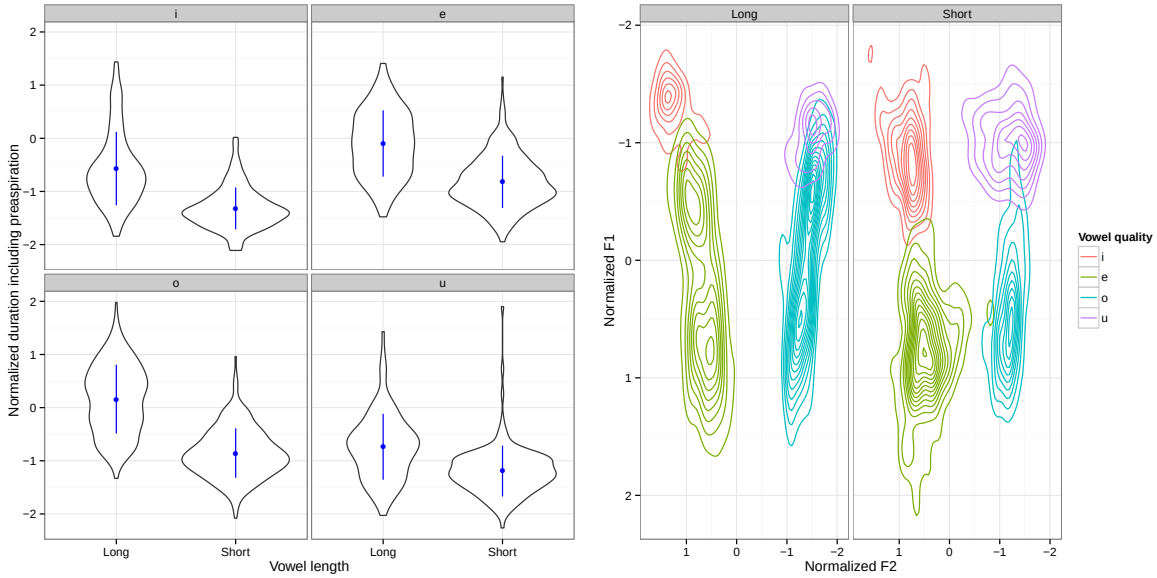
Outline of argument

- Are there criteria we can use beyond surface predictability?

☞ Yes: *modularity*

☞ If a distinction participates in a pattern that involves proprietary phonological information, it should be phonological

- 'Tenseness' is likely phonologized both in SW Welsh and other varieties
- Predictable distribution of distinct categories is an expected result of the life cycle, not a problem for the Contrastivist Hypothesis
- Contrastivity is defined as non-redundancy in feature assignment along the lines of the contrastive hierarchy



(a) Vowel duration by category

(b) Vowel quality by vowel length

Figure 2: Duration and vowel quality for south-western speakers

2 Dialect variation

2.1 South-West Welsh

Acoustic study

- 8 speakers in study: 6 show the system described for the south-west
- Carmarthen, rural W Carmarthenshire, Pembrokeshire
- 149 items × 3 repetitions, controlled for consonantal context, vowel length, height of following vowel
- Carrier phrase *Glywes i'r gair* __ *ddoe* 'I heard the word __ yesterday'
- Basically: descriptions are correct

- Figure 2a: robust durational distinction, as expected for South Welsh
- Figure 2b: clearly bimodal pattern in the mid long vowels but not in high vowels
- 'Lax' long vowels seem fairly similar to short vowels
- Quantitative results: generalized additive hierarchical models using R package `mgcv` (Wood 2006), speaker and word as random effects
- Improved fit with three-way interaction between vowel quality, vowel length and height of following vowel
- In this model, the height of the following vowel has a significant effect (95% CI excludes zero) only on long /eː oː/, again as expected from descriptions

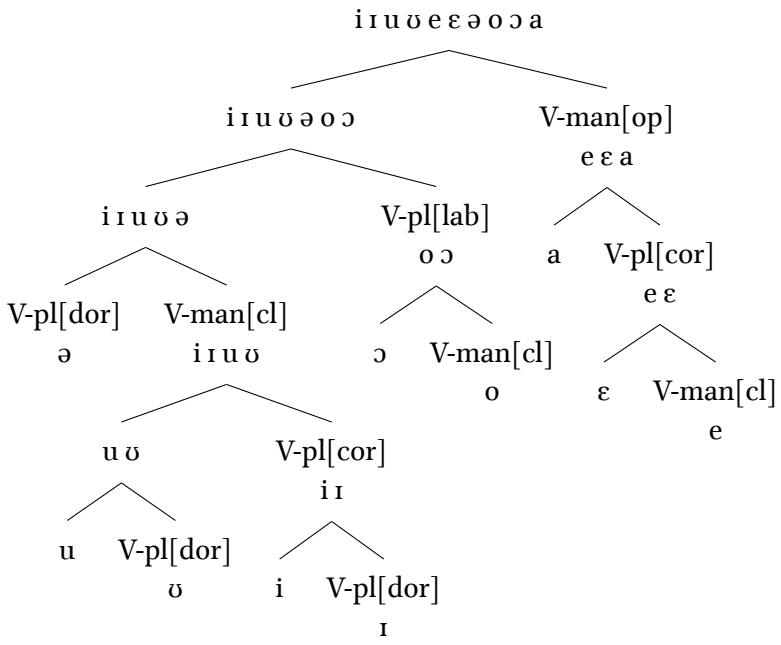


Figure 3: Contrastive hierarchy for South-West Welsh

Analysis

- The 'tense-lax' distinction in *mid* vowels is sensitive to the 'high-nonhigh' distinction among *all* vowels
- The height specification of vowels is a proprietary phonological feature

☞ Hence, the 'tense-lax' distinction in mid vowels is phonological

- Emergent/substance-free feature theory (e. g. Mielke 2007, Morén 2007): these two distinctions pattern together, so they are encoded by the same feature
- Important fact: patterning of vowels in unstressed (post-tonic) syllables
  - [i u] in open syllables, [ɪ ʊ] in closed syllables
  - Only [ɛ ɔ] for mid vowels

- Parallel Structures Model of feature geometry (e. g. Morén 2003, 2006, 2007, Youssef 2010)
- Different implementation of 'tenseness' in high and mid vowels
  - High vowels: 'lax' [ɪ ʊ] are more marked, pattern with [ə] in that this is the class of vowels that can never be long
  - Mid vowels: 'tense' [e o] are more marked
    * Only [ɛ ɔ] in post-tonic syllables
    * Tense [e o] phonologically active: targeted by dissimilation process
    * The feature V-manner[closed] covers both high vowels and tense mid vowels
    * Dissimilation within the final disyllabic domain responsible for alternations

	V-place			V-manner	
Segment	[coronal]	[labial]	[dorsal]	[open]	[closed]
/i/	✓				✓
/ɪ/	✓		✓		✓
/u/					✓
/ʊ/			✓		✓
/ə/			✓		
/e/	✓			✓	✓
/ɛ/	✓			✓	
/o/		✓			✓
/ɔ/		✓			
/a/				✓	

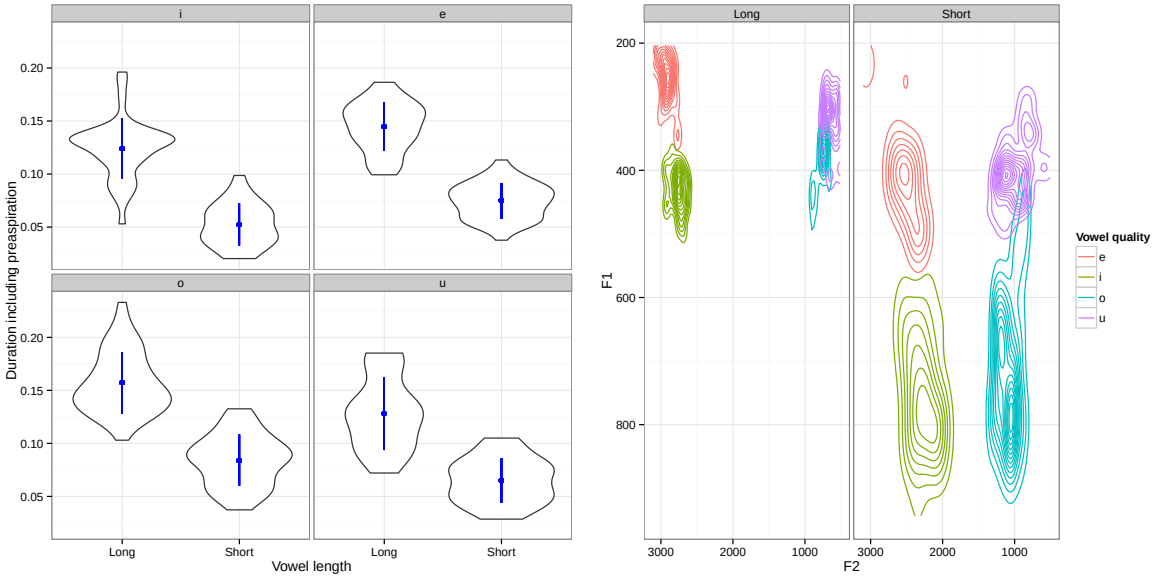
Table 1: Featural specifications for vowels: South-West Welsh

Phonologization in South-West Welsh

- The 'tenseness' distinction shows signs of *phonologization* (Hyman 1976, 2013) or *stabilization* (Bermúdez-Otero & Trousdale 2012, Bermúdez-Otero 2014, Ramsammy 2015): reference to phonological information
  - Distribution in high vowels is sensitive to the presence of a coda
  - ☞ Modelling shows this is not a durational effect
  - Distribution in mid vowels is sensitive to contrastive phonological specification
  - ☞ We return to possible continuous effects below
- Most speakers consistently show unexpected [ɛː] in *ffenestr* [ˈfɛːnɛst] 'window'
- *Phonemicization*: contrastive by any criterion

2.2 Standard system

- This system is exemplified in the data by a single speaker
- Figure 6a: robust distinction in duration
- Figure 6b: 'tense' when long and 'lax' when short
- Similar to findings for monosyllables in Mayr & Davies (2011)
- Post-tonic syllables
  - Lax [ɪ ʊ] when closed, tense [i u] when open
  - Lax [ɛ ɔ] in all contexts
- Overall distribution:
  - High vowels: lax in closed syllables (unstressed or short before moraic coda), tense in open syllables
  - Mid vowels: lax when monomoraic, tense when bimoraic



(a) Vowel duration by category

(b) Vowel quality by vowel length

Figure 6: Duration and vowel quality for Sp1

- High vowels: lax member is marked
- Mid vowels: tense member is marked
- The specifications in table 2 basically overlay this on the analysis for Welsh vowels in Iosad (2012b)

Summary on standard system

- 'Tenseness' probably phonologized: sensitive to phonological information
  - High vowels: presence of codas
  - Mid vowels: moraic structure
  - ☞ Not a duration effect
- The features used for the 'tenseness' distinction do not interact with anything else or with each other
- No evidence this is the same feature

2.3 The non-enhanced system

- Again, just a single speaker: notably, this speaker is from Aberystwyth in the Mid Wales area
- Figure 8a: small but robust difference in duration by vowel category
- ☞ This *contradicts* the descriptions claiming 'free variation between "short" and "long" vowels'
- Figure 8b: no difference in formant values by length category: all stressed vowels are 'lax'
- Figure 10: longer duration does lead to some gradient tensing in stressed vowels
- Same post-tonic system as elsewhere

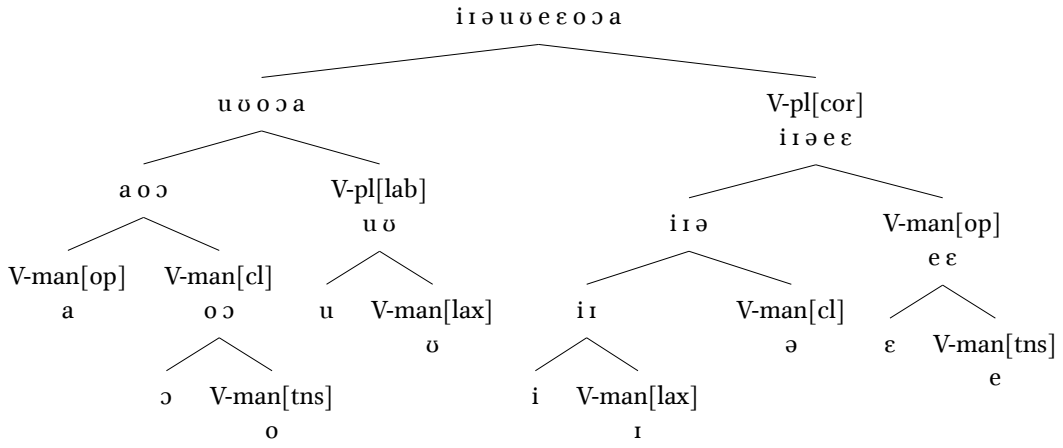
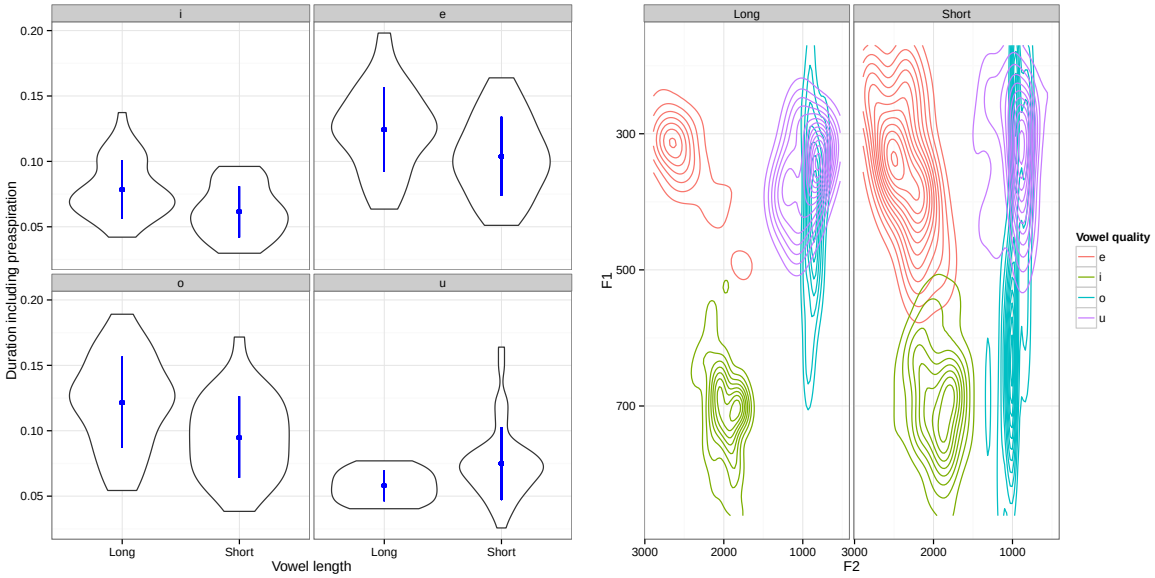


Figure 7: Contrastive hierarchy for the standard system

	V-manner				V-place	
Segment	[closed]	[open]	[tense]	[lax]	[labial]	[coronal]
/i/						✓
/ɪ/				✓		✓
/ə/	✓					✓
/u/					✓	
/ʊ/				✓	✓	
/e/		✓	✓			✓
/ɛ/		✓				✓
/o/	✓		✓			
/ɔ/	✓					
/a/		✓				

Table 2: Featural representations for the standard system



(a) Vowel duration by category

(b) Vowel quality by vowel length

Figure 8: Duration and vowel quality for Sp8

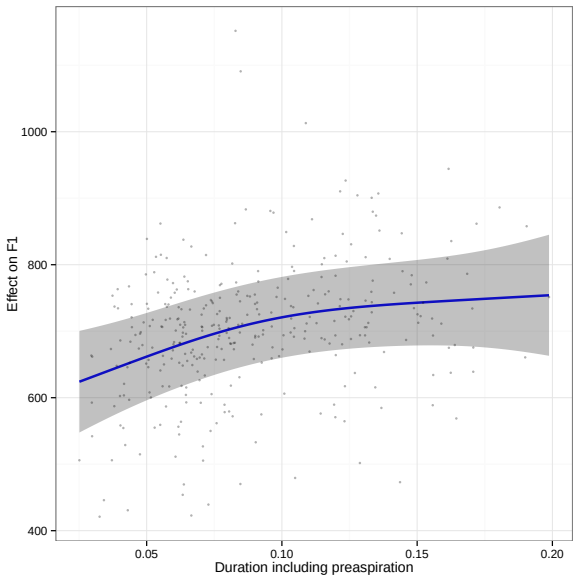


Figure 10: Effect of vowel duration on F1, Sp8

Summary for non-enhanced system

- No evidence for a phonological 'tenseness' distinction in mid vowels
- Some evidence for a distinction in high vowels sensitive to codas, but only apparent word-finally

☞ Note the broader domain of the requirement compared to the standard system

- No analysis here due to lack of data from stressed monosyllables
- Potentially: 'free variation' in quantity really means '(some) continuous variation in quality'
- Some descriptive literature can be interpreted to agree with this (Wmffre 2003, Rees 2013)

3 Phonologization across dialects

3.1 Diachronic interpretation

- Suggested diachronic interpretation for stressed vowels
  0. No difference in quality within vowel categories
  1. Length is enhanced by (continuous) tensing (Stevens & Keyser 1989, 2010, Keyser & Stevens 2006) ≈ non-enhanced system
  2. All short-long pairs are interpreted as featurally distinct, but the features are inert otherwise ≈ standard system
  3. Features used for the tenseness distinction participate in alternations involving other segments ≈ south-western system
  4. Tenseness becomes phonemicized (see also Iosad 2014 for another scenario)

Where does contrast come from?

- If features are emergent, they must be extracted from categorical distributions in the data
- Categorical distributions arise from phonetic processes with predictable outcomes via the life cycle
- For the life cycle, see for instance Bermúdez-Otero (2007, 2014), Bermúdez-Otero & Trousdale (2012), Roberts (2012), Strycharczuk (2012), Strycharczuk et al. (2014), Turton (2014), Ramsammy (2015)
- At early stages of the life cycle, the categories will be in predictable ('complementary') distribution
- Some learning models are biased to collapse such distinctions (e. g. Peperkamp et al. 2006, Dillon, Dunbar & Idsardi 2012)
- But the distribution may also be interpreted to be driven by the grammar (K. C. Hall 2013, Kiparsky 2014)

3.2 Rule scattering in South-West Welsh

The origin of height dissimilation

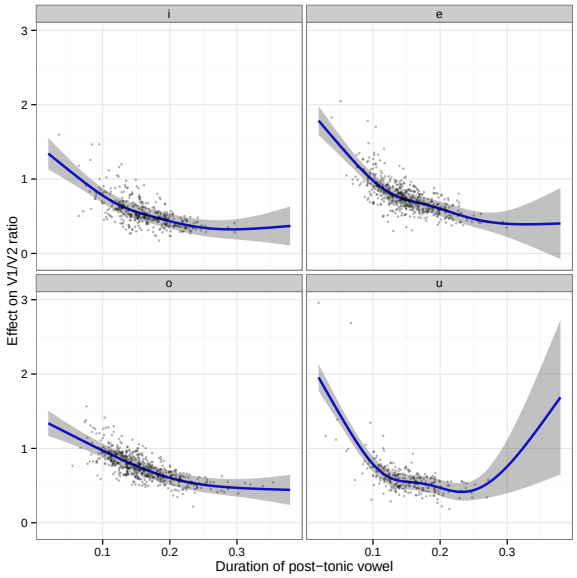


Figure 11: Effect of post-tonic vowel duration on V1/V2 duration ratio, by stressed vowel, south-western speakers

- Height dissimilation: phonologization of a trade-off in inherent length
- Irish: synchronically (Munster; Ó Sé 1989) and diachronically (Connacht; Ó Sé 1984) ⇒ categorical (?)
- East Slavic: categorical (Crosswhite 2000) or continuous (Kasatkina & Ščigel' 1996, Kniazev & Shaulskiy 2007), potentially coexisting
- Kera: continuous? (Pearce 2007)

- The following model was used to estimate the effect of post-tonic vowel duration on the ratio between the duration of the stressed and post-tonic vowel

```
fit <- gam(v1h.v2h.ratio ~ s(v2h.dur, by=v1, k=5) +
         v1 + v1.is.long + s(speaker, bs='re') + s(word, bs='re'),
         data=sw.data)
```

- Figure 11 shows that the relationship is consistent with the existence of a trade-off
- The coexistence of a continuous pattern and its categorical congener in the grammar is major prediction of the theory of the life cycle: *rule scattering*
- South-West Welsh is an interesting example of rule scattering, since the cognate processes are rather different in nature (unlike t/d-deletion, [l]-darkening etc.)

3.3 Emergent features and phonologization

Phonologization and labelling

- Emergent/substance-free feature theory is compatible with theories of the life cycle
- Entities to be labelled emerge from categorical distributions in the data
- Categorical distributions in behaviour may be generated by underlyingly non-categorical processes (cf. Ladd 2006)
- Phonologized distinctions participate in 'narrowly phonological' patterns even when the evidence for their exact nature is weak

Emergent features and contrast

- Phonologization in this sense is an alternative to surface contrast as a criterion for 'redundancy'
- Features like 'tenseness' in systems like Welsh are not 'redundant' even if they may be predictable on the surface from the context
- The Contrastivist Hypothesis is worth pursuing with a revised definition of 'redundancy'
- Consistency with the Successive Division Algorithm (Dresher 2009) is a good candidate criterion (cf. Dresher 2014)

References

Awbery, Gwenllian M. 1984. Phonotactic constraints in Welsh. In Martin J. Ball & Glyn E. Jones (eds.), *Welsh phonology: Selected readings*, 65–104. Cardiff: University of Wales Press.

Awbery, Gwenllian M. 1986. *Pembrokeshire Welsh: A phonological study*. Llandysul: Welsh Folk Museum.

Ball, Martin J. & Briony Williams. 2001. *Welsh phonetics* (Welsh Studies 17). Lewiston, Queenston, Lampeter: Edwin Mellen Press.

Bermúdez-Otero, Ricardo. 2007. Diachronic phonology. In Paul de Lacy (ed.), *The Cambridge handbook of phonology*, 497–518. Cambridge: Cambridge University Press.

Bermúdez-Otero, Ricardo. 2014. Amphichronic explanation and the life cycle of phonological processes. In Patrick Honeybone & Joseph C. Salmons (eds.), *The Oxford handbook of historical phonology*. Oxford: Oxford University Press.

Bermúdez-Otero, Ricardo & Graeme Trousdale. 2012. Cycles and continua: On unidirectionality and gradualness in language change. In Terttu Nevalainen & Elizabeth Closs Traugott (eds.), *Handbook on the history of English: Rethinking approaches to the history of English*, 691–720. Oxford: Oxford University Press.

Booij, Gerhard. 1995. *The phonology of Dutch*. Oxford: Oxford University Press.

Botma, Bert & Marc van Oostendorp. 2012. A propos of the Dutch vowel system 21 years on, 22 years on. In Bert Botma & Roland Noske (eds.), *Phonological explorations: Empirical, theoretical and diachronic issues*, 135–154. Berlin: De Gruyter.

Botma, Bert, Koen Sebregts & Dick Smakman. 2012. The phonetics and phonology of Dutch mid vowels before /l/. *Laboratory Phonology* 3(2).

Bye, Patrik & Paul de Lacy. 2008. Metrical influences on fortition and lenition. In Joaquim Brandão de Carvalho, Tobias Scheer & Philippe Ségéral (eds.), *Lenition and fortition* (Studies in Generative Grammar 99), 173–2006. Berlin: Mouton de Gruyter.

Chomsky, Noam & Morris Halle. 1967. *The sound pattern of English*. New York: Harper & Row.

Crosswhite, Catherine M. 2000. Vowel reduction in Russian: A unified account of standard, dialectal, and 'dissimilative' patterns. In Catherine M. Crosswhite & Joyce McDonough (eds.), *University of Rochester working papers in the language sciences*, vol. Spring 2000, 107–171.

Dillon, Brian, Ewan Dunbar & William Idsardi. 2012. A single-stage approach to learning phonological categories: Insights from Inuktitut. *Cognitive Science* 37(2). 344–377.

Dresher, B. Elan. 2009. *The contrastive hierarchy in phonology*. Cambridge: Cambridge University Press.

Dresher, B. Elan. 2014. The arch not the stones: Universal feature theory without universal features. *Nordlyd* 41(2): *Special issue on features*. 165–181.

Durand, Jacques. 2005. Tense/lax, the vowel system of English and phonological theory. In Philip Carr, Jacques Durand & Colin J. Ewen (eds.), *Headhood, elements, specification, and contrastivity: papers in honour of John Anderson* (Current Issues in Linguistic Theory 259), 77–97. Amsterdam: John Benjamins.

Eliasson, Stig. 1985. Stress alternations and vowel length: New evidence for an underlying nine-vowel system in Swedish. *Nordic Journal of Linguistics* 8(2). 101–129.

Fretheim, Thorsten. 1969. Norwegian stress and quantity reconsidered. *Norsk tidsskrift for sprogvidenskap* 23. 76–96.

Hall, Daniel Currie. 2007. *The role and representation of contrast in phonological theory*. Toronto: University of Toronto PhD thesis.

Hall, Kathleen Currie. 2013. A typology of intermediate phonological relationships. *The Linguistic Review* 30(2). 215–275.

Hall, Tracy Alan. 1992. *Syllable structure and syllable-related processes in German*. Tübingen: Max Niemeyer Verlag.

Hyman, Larry M. 1976. Phonologization. In Alphonse Juilland (ed.), *Linguistic studies presented to Joseph H. Greenberg*, 407–418. Saratoga: Anna Libri.

Hyman, Larry M. 2013. Enlarging the scope of phonologization. In Alan C. L. Yu (ed.), *Origins of sound change: Approaches to phonologization*, 3–28. Oxford: Oxford University Press.

Iosad, Pavel. 2012a. Final devoicing and vowel lengthening in Friulian: A representational approach. *Lingua* 122(8). 922–951.

Iosad, Pavel. 2012b. *Representation and variation in substance-free phonology: A case study in Celtic*. Tromsø: University of Tromsø PhD thesis.

Iosad, Pavel. 2014. The ATR/Laryngeal connection and emergent features. MS., University of Edinbrgh. in preparation.

Jones, Christine & David Thorne. 1992. *Dyfed: Blas ar ei thafodieithoedd*. Llandysul: Gwasg Gomer.

Jones, Glyn E. 1984. The distinctive vowels and consonants of Welsh. In Martin J. Ball & Glyn E. Jones (eds.), *Welsh phonology: Selected readings*, 40–64. Cardiff: University of Wales Press.

Kasatkina, R. F. & Ye. V. Ščigel'. 1996. Osobennosti prosodii slova v južnorusskix govorax. In T. M. Nikolaeva (ed.), *Prosodičeskij stroj russkoj reči*, 236–255. Moscow: RAS Russian Language Institute.

Keyser, Samuel Jay & Kenneth N. Stevens. 2006. Enhancement and overlap in the speech chain. *Language* 82(1). 33–63.

Kiparsky, Paul. 2014. Phonologization. In Patrick Honeybone & Joseph C. Salmons (eds.), *The Oxford handbook of historical phonology*. Oxford: Oxford University Press.

Kniazev, Sergey & Evgeny Shaulskiy. 2007. The development of *akanje* in Russian: new data. In *Proceedings of ICPhS XVI*, 1425–1428. Saarbrücken. `http://www.icphs2007.de/conference/Papers/1211/1211.pdf`.

Kristján Árnason. 1980. *Quantity in historical phonology: Icelandic and related cases* (Cambridge Studies in Linguistics 30). Cambridge: Cambridge University Press.

Kristoffersen, Gjert. 1999. Quantity in Norwegian syllable structure. In Harry van der Hulst & Nancy Ritter (eds.), *The syllable: Views and facts* (Studies in Generative Grammar 45), 631–650. Berlin: Mouton de Gruyter.

Labov, William. 1994. *Principles of linguistic change*. Vol. Internal factors. Oxford: Blackwell.

Ladd, D. Robert. 2006. 'Distinctive phones' in surface representation. In Louis M. Goldstein, D. H. Whalen & Catherine T. Best (eds.), *Phonetics and phonology: Laboratory Phonology 8*, 3–26. Berlin: Mouton de Gruyter.

Mayr, Robert & Hannah Davies. 2011. A cross-dialectal acoustic study of the monophthongs and diphthongs of Welsh. *Journal of the International Phonetic Association* 41(1). 1–25.

Mielke, Jeff. 2007. *The emergence of distinctive features*. Oxford: Oxford University Press.

Morén, Bruce. 2001. *Distinctiveness, coercion, and sonority: A unified theory of weight*. London, New York: Routledge.

Morén, Bruce. 2003. The Parallel Structures model of feature geometry. In *Working Papers of the Cornell Phonetics Laboratory*, vol. 15, 194–270. Ithaca, NY.

Morén, Bruce. 2006. Consonant–vowel interactions in Serbian: Features, representations and constraint interactions. *Lingua* 116(8). 1198–1244.

Morén, Bruce. 2007. The division of labour between segment-internal structure and violable constraints. In Sylvia Blaho, Patrik Bye & Martin Krämer (eds.), *Freedom of analysis?* (Studies in Generative Grammar 95), 313–344. Berlin: Mouton de Gruyter.

Murray, Robert W. 2000. Syllable cut prosody in Early Middle English. *Language* 76(3). 617–654.

Ó Sé, Diarmuid. 1984. Coimriú siollaí tosaigh sa Ghaeilge. *Éigse* 20. 171–186.

Ó Sé, Diarmuid. 1989. Contributions to the study of word stress in Irish. *Ériu* 40. 147–178.

Pearce, Mary. 2007. ATR allophones or undershoort in Kera? *UCL Working Papers in Linguistics* 19. Richard Breheny & Nikolaos Velegrakis (eds.).

Peperkamp, Sharon, Rozenn Le Calvez, Jean-Pierre Nadal & Emmanuel Dupoux. 2006. The acquisition of allophonic rules: Statistical learning with linguistic constraints. *Cognition* 101(3). B31–B41.

Ramsammy, Michael. 2015. The life cycle of phonological processes: Accounting for dialectal microtypologies. *Language and Linguistics Compass* 9(1). 33–54.

Rees, Iwan Wyn. 2013. *Astudiaeth o amrywiadau ffonolegol mewn dwy ardal yng nghanolbarth Cymru*. Aberystwyth: Aberystwyth University PhD thesis.

Rice, Curt. 2006. Norwegian stress and quantity: the implications of loanwords. *Lingua* 116(7). 1171–1194.

Roberts, Philip J. 2012. Latin rhotacism: A case study in the life cycle of phonological processes. *Transactions of the Philological Society* 110(1). 80–93.

Smith, Norval, Roberto Bolognesi, Frank van der Leeuw, Jean Rutten & Heleen de Wit. 1989. Apropos of the Dutch vowel system 21 years on. In Hans Bennis & Ans van Kemenade (eds.), *Linguistics in the Netherlands 1989*, 133–142. Dordrecht: Foris.

Spiekermann, Helmut. 2000. *Silbenschnitt in deutschen Dialekten* (Linguistische Arbeiten 425). Tübingen: Max Niemeyer Verlag.

Stevens, Kenneth N. & Samuel Jay Keyser. 1989. Primary features and their enhancement in consonants. *Language* 65(1). 81–106.

Stevens, Kenneth N. & Samuel Jay Keyser. 2010. Quantal theory, enhancement and overlap. *Journal of Phonetics* 38(1). 10–19.

Strycharczuk, Patrycja. 2012. *Phonetics–phonology interaction in pre-sonorant voicing*. Manchester: University of Manchester PhD thesis.

Strycharczuk, Patrycja, Marijn Van 'T Veer, Martine Bruil & Kathrin Linke. 2014. Phonetic evidence on phonology–morphosyntax interactions: Sibilant voicing in Quito Spanish. *Journal of Linguistics* 50(2). 403–453.

Torres-Tamarit, Francesc. Forthcoming(a). Compensatory and opaque vowel lengthening in Harmonic Serialism. In John J. McCarthy & Joe Pater (eds.). London: Equinox.

Torres-Tamarit, Francesc. Forthcoming(b). Length and voicing in Friulian and Milanese. *Natural Language & Linguistic Theory*.

Turton, Danielle. 2014. *Variation in English /l/: Synchronic reflections on the life cycle of phonological processes*. Manchester: University of Manchester PhD thesis.

Watkins, Arwyn T. 1967. Some phonological features of the Welsh dialect of Llansamlet (West Glamorgan). In Wolfgang Meid (ed.), *Beiträge zur Indogermanistik und Keltologie: Julius Pokorny zum 80. Geburtstag gewidmet*, 315–322. Innsbruck: Sprachwissenschaftliches Institut der Universität Innsbruck.

Wmffre, Iwan. 2003. *Language and place-names in Wales: The evidence of toponymy in Cardiganshire*. Cardiff: University of Wales Press.

Wood, Simon N. 2006. *Generalized additive models: An introduction with R*. Chapman & Hall/CRC.

Youssef, Islam. 2010. Laryngeal assimilation in Buchan Scots. *English Language and Linguistics* 14(3). 321–345.

Zonneveld, Wim, Mieke Trommelen, Michael Jessen, Gösta Bruce & Kristjan Árnason. 1999. Word-stress in West Germanic and North Germanic languages. In Harry van der Hulst (ed.), *Word prosodic systems in the languages of Europe* (Empirical Approaches to Language Typology 20), 477–604. Berlin: Mouton de Gruyter.

	No height effect	No interaction	Model with interaction
Intercept	-1.01^*	-1.06^*	-1.00^*
	$[-1.24; -0.77]$	$[-1.29; -0.83]$	$[-1.18; -0.82]$
//ə//	0.71^*	0.65^*	0.79^*
	$[0.44; 0.98]$	$[0.39; 0.90]$	$[0.57; 1.00]$
//e//	1.55^*	1.42^*	1.58^*
	$[1.28; 1.82]$	$[1.17; 1.68]$	$[1.34; 1.82]$
//o//	1.59^*	1.50^*	1.54^*
	$[1.26; 1.91]$	$[1.19; 1.82]$	$[1.26; 1.81]$
//u//	0.26	0.14	0.29
	$[-0.09; 0.61]$	$[-0.20; 0.48]$	$[-0.04; 0.62]$
Long vowel	-0.22	-0.29^*	-0.25^*
	$[-0.50; 0.06]$	$[-0.55; -0.03]$	$[-0.47; -0.04]$
Long /e/	-0.26	-0.16	-0.83^*
	$[-0.62; 0.10]$	$[-0.50; 0.18]$	$[-1.15; -0.52]$
Long /o/	0.00	0.08	-0.38^*
	$[-0.36; 0.37]$	$[-0.27; 0.42]$	$[-0.68; -0.08]$
Long /u/	0.34	0.34	0.35
	$[-0.10; 0.77]$	$[-0.07; 0.75]$	$[-0.16; 0.85]$
Duration smooth	1.86	2.37	2.13
	$[-2.70; 6.42]$	$[-3.35; 8.10]$	$[-3.04; 7.31]$
F2 smooth	3.33	3.50	3.79
	$[-4.04; 10.70]$	$[-4.06; 11.05]$	$[-3.97; 11.56]$
Speaker (random)	4.41	4.43	4.35
	$[-5.39; 14.21]$	$[-5.37; 14.23]$	$[-5.45; 14.15]$
Word (random)	98.37	96.29	76.98
	$[-117.23; 313.97]$	$[-119.30; 311.89]$	$[-122.94; 276.90]$
High post-tonic vowel		0.27^*	0.05
		$[0.15; 0.38]$	$[-0.27; 0.36]$
//e// before high			-0.08
			$[-0.47; 0.30]$
//o// before high			0.02
			$[-0.36; 0.39]$
//u// before high			-0.18
			$[-0.61; 0.25]$
Long vowel before high			0.03
			$[-0.35; 0.42]$
Long //e// before high			1.06^*
			$[0.57; 1.54]$
Long //o// before high			0.82^*
			$[0.34; 1.30]$
Long //u// before high			0.05
			$[-0.60; 0.69]$
AIC	2098.91	2091.54	2074.06
BIC	2762.91	2753.46	2672.18
Log Likelihood	-931.50	-928.18	-930.77
R^2	0.79	0.79	0.79

* 0 outside the confidence interval

Table 3: Models for normalized F1, south-western speakers